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[001] PLANETARY GEAR FOR MOUNTING ON AN ELECTROMOTOR

[002] insert <a1>

Sub a2> [003] The invention relates to a planetary gear for mounting on an electromotor, according to the pre-characterising portion of the principal claim.

[004]

[005] Such planetary gears are used for many purposes in automation technology and plant and machinery in general. With such a planetary gear, in which a sun gear can be driven by an output shaft of the electromotor, an annular gear is positioned in the housing and a planetary carrier forms the output, various transmission ratios, typically in the range 4:1 to 10:1, can be produced by varying the geometry of the sun gear and planetary gear wheels and of the planetary carrier.

[006] Owing to the high power density involved, even small internal power losses can give rise to undesired high temperatures. Because of the compactness of the structure, the heat generated by these losses often cannot be dissipated to the desired extent. High temperatures affect service life adversely. A large part of the power loss is attributable to the seals and bearings of the rapidly rotating sun gear shaft on the input side.

[007] A gear of this type is disclosed for example in DE 198 08 184 C1. To receive an output shaft of the electromotor, the sun gear shaft of this known planetary gear is made hollow in a receiving area of enlarged diameter. The sun gear shaft is sealed with respect to the housing by a radial sealing ring.

Sub a3> [008] A

[009] The purpose of the present invention is to develop further a planetary gear of the type described so as to minimise the power loss. Furthermore, the planetary gear should be of compact structure and economical to manufacture.

[010] The invention's objectives are achieved by a planetary gear of the said type incorporating ~~also~~ the features of the characterising portion of the principal claim.

[011] Thus, in accordance with the invention the sealing element that seals the sun gear shaft on the outside with respect to the housing is arranged axially

outside the receiving area for the output shaft of the electromotor in an axial section of the sun gear shaft with a reduced outer diameter compared with the receiving area. As a result of the smaller outer diameter, considerably less heat is generated by power loss between the rapidly rotating sun gear shaft and the sealing element. In addition, seal wear and seal leakage are reduced and the cost of the sealing element is lower.

[012] In an advantageous embodiment of the invention a bearing is provided for the sun gear shaft, whose inner ring is arranged axially outside the receiving area for the output shaft of the electromotor, on an axial section of the sun gear shaft with a reduced outer diameter compared to the receiving area. Compared with a bearing arranged in the receiving area of the sun gear shaft or directly adjacent thereto, such a bearing can be made of a size commensurate with the load occurring and does not need to be made oversize. The smaller size of the bearing results in less power loss and is both more economical and lighter. Naturally, instead of two separate components for the sealing element and the bearing, a bearing with an integrated sealing element can also be used.

[013] In a further advantageous embodiment of the invention the outer bearing ring of the sun gear shaft bearing is not positioned in the housing, but in the planetary carrier. Since the planetary carrier rotates in the same direction as the sun gear wheel, the relative rotation speed between the sun gear shaft and the planetary carrier is lower than the relative rotation speed between the sun gear shaft and the housing. This results in further reduction of the power loss, with further improvement in the gear efficiency.

[014] Advantages in relation to compact size can be achieved by arranging the bearing for the sun gear shaft radially inside an inner ring of a planetary carrier bearing and axially at least partly within the structural space occupied by the planetary carrier bearing.

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[015]

[016] Other advantageous features of the invention are explained with reference to the attached drawing, which shows a longitudinal section through a planetary gear according to the invention.

[017]

[018]

[019] In the single figure attached, the housing is indexed as 2, the sun gear shaft on the input side as 4 and the output shaft of a planetary gear according to the invention as 6. The output shaft 6 rotates with a planetary carrier 8, on which several uniformly distributed planetary gear wheels 10 are mounted and able to rotate. The planetary gear wheels 10 are in simultaneous gear-tooth engagement with a central sun gear 12 that can be driven by the sun gear shaft 4 and with an annular gear 14 fixed in the housing 2.

[020] To receive an output shaft (not shown) of an electromotor, the sun gear shaft 4 has a hollow receiving area 16 that extends axially over the length of a cylindrical bore 18 in the sun gear shaft 4. The inside space of the housing 2 is filled with lubricant and sealed with respect to the outside by two sealing elements formed as radial sealing rings 20, 22. The radial sealing rings are fixed in the housing 2 and are associated with cylindrical functional surfaces 24, 26 of the output shaft and the sun gear shaft respectively. Sliding friction takes place between the radial sealing rings and the said functional surfaces.

[021] According to the invention, the radial sealing ring 22 arranged between the housing 2 and the sun gear shaft 4 is positioned outside the receiving area 16 for the output shaft of the electromotor in an axial section of the sun gear shaft whose outer diameter is smaller compared with that of the receiving area. Only very small frictional losses occur on the functional surface 26, whose diameter is smaller than the diameter of the bore 18, so that higher efficiency is attained and problems due to high temperatures are avoided. Between the receiving area 16 and the location of the radial sealing ring 22 the sun gear shaft has a diameter step 23.

[022] The inner ring of the bearing 28 for the sun gear shaft 4 is also arranged outside the receiving area 16 for the output shaft of the electromotor in an area with reduced outer diameter, so that a bearing of smaller size can be used.

[023] The diameter of the bearing holder on the sun gear shaft is also smaller than the diameter of the bore 18.

[024] The outer bearing ring of the bearing 28 is located in the planetary carrier 8, radially inside the inner ring of a planetary carrier bearing 30. The bearing 28 is positioned axially within the structural space occupied by the planetary carrier bearing 30, and this makes it possible for the axial length of the planetary gear to be short. For the planetary carrier 8 a second bearing 32 is provided which, like the bearing 30, is in the form of a conical-roller bearing and which forms an X arrangement together with the latter.

[025] In the axial space between the conical-roller bearings 30, 32 the planetary carrier 8 has on the two sides of each planetary gear wheel 10 bores 34, 36 that extend through the carrier. These bores 34, 36 each accommodate a planetary bearing pin 38, on which the planetary gear wheel 10 is mounted by means of cylindrical rollers 40 and can rotate. The end surface of the planetary bearing pin 40 abuts against the inner ring of the planetary carrier bearing 32, 34, so that it is advantageously secured against axial displacement without further measures. On each side of each planetary gear wheel 10 thrust washers in the form of annular discs are arranged on the planetary bearing pin 38, and these restrict the axial movement of the planetary gear 10.

[026] The bearing 28 for the sun gear shaft 4 is secured in the planetary carrier 8 against axial displacement in one direction by a circlip 46. To fit the bearing 28, the circlip 46 can be pressed completely into an annular groove 48 in the planetary carrier, which is axially adjacent to the functional surface 47 that receives the outer ring of the bearing. As soon as the outer ring of the bearing 28 has been pushed past the area of the annular groove 48 during assembly, the circlip 46 snaps together and so secures the outer ring of the bearing against axial displacement. The inner bearing ring of the bearing 28 is located axially on the sun gear shaft 4

in a position limited by a securing ring 50 and by a diameter step 52 in the sun gear shaft 4.

[027] Between the face of the outer bearing ring of the bearing 28 opposite the circlip 46 and an annular disc-shaped functional surface 54 of the planetary carrier 8 is positioned a rubber O-ring 56, which serves as an elastic compensating element. Thus, the sun gear shaft 4 can undergo slight axial displacement relative to the planetary carrier 8 and the housing 2 against the restoring force action of the O-ring 56. In this way length expansions of the sun gear shaft 4 and/or the output shaft of the electromotor resulting from temperature changes can be compensated. As an alternative, the sun gear shaft can be fitted so that it cannot move axially relative to the housing and a spring disc coupling, such as that shown in the document DE 199 51 613 not published earlier, can be positioned between the sun gear shaft 4 and the output shaft of the electromotor.

Index numbers

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|---|---|---|---|
| 2 | housing | 30 | bearing |
| 4 | sun gear shaft | 32 | bearing |
| 6 | output shaft | 34 | bore |
| 8 | planetary carrier | 36 | bore |
| 10 | planetary gear wheel | 38 | planetary bearing pin |
| 12 | sun gear | 40 | cylindrical rollers |
| 14 | annular gear | 42 | thrust washer |
| 16 | receiving area | 44 | thrust washer |
| 18 | bore | 46 | circlip |
| 20 | radial sealing ring | 47 | functional surface |
| 22 | radial sealing ring | 48 | annular group |
| 23 | diameter step | 50 | securing ring |
| 24 | functional surface | 52 | step |
| 26 | functional surface | 54 | functional surface |
| 28 | bearing | 56 | O-ring |